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BHI-00772
Revision 1

Design Criteria and Design Basis for the 100-HR-3 and 100-KR-4 Pump-and-Treat Projects

Environmental Excellence
HANFORD

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Bechtel Hanford, Inc.
Richland, Washington

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Revision 1

Design Criteria and Design Basis for the 100-HR-3 and 100-KR-4 Pump-and-Treat Projects

Authors

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June 1996

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PREFACE

Revision 1 of the *Design Criteria And Design Basis for the 100-HR-3 and 100-KR-4 Pump-and-Treat Projects* is a complete replacement and therefore supersedes the revision 0 document issued in May 1996. The major changes incorporated into this revision follow:

An existing well (K-20) in the K Area was originally proposed for use as an extraction well. Instead, a new well (K-119A) will be constructed as a replacement, and K-20 will be used as a compliance well. These changes are reflected in the text, Table 3-1, and Figure 3-3 of **Section 3 - Design Basis**.

In **Subsection 3.7 Treatment System**, the selection of ion exchange resin SIR-700 for initial operation is noted.

In **Subsection 3.2.1 Construction Requirements,** Item 6, the second paragraph was modified to reflect issuance of DOE/RL-96-44, *Treatment Plan for Protection of Cultural Resources for the 100-KR-4 Pump-and-Treat Project*.

The only other changes made were editorial corrections.

ACRONYMS

ARAR	applicable or relevant and appropriate requirement
BHI	Bechtel Hanford, Inc.
BOP	balance of plant
CHI	CH2M HILL Hanford, Inc.
DOE-RL	U.S. Department of Energy, Richland Operations Office
DOW	description of work
ERC	Environmental Restoration Contractor
ERDF	Environmental Restoration Disposal Facility
IRM	interim remedial measure
IX	ion exchange
PLC	programmable logic controller
RAO	remedial action objective
RDR/RAWP	remedial design report/remedial action work plan
ROD	record of decision
TCLP	toxicity characteristic leaching procedure
WAC	Washington Administrative Code

1.0 PROJECT INTRODUCTION

This document describes the project objectives and design criteria to be used for the 100-HR-3 and 100-KR-4 groundwater pump-and-treat design efforts. This document is intended to serve as a vehicle for early documentation and approval of Bechtel Hanford, Inc. (BHI) project objectives and design criteria while the detailed design work progresses concurrently. The format and content of this document originate from BHI engineering department project instructions 4.01-01 and 4.03-01, which generally require separate design criteria and design basis documents (BHI, 1996b). The design criteria and design basis documents have been merged into this single design criteria document to accommodate an accelerated procurement schedule and facilitate Environmental Restoration Contractor (ERC) review.

The information contained herein describes the CH2M HILL Hanford, Inc. (CHI) understanding of the project objectives and the assumptions and existing conditions to be used in developing the project design. The design effort was undertaken prior to issuance of a final interim record of decision (ROD). The final ROD was signed on April 1, 1996, and its regulatory considerations will be reflected in the final design (EPA, 1996).

This document is intended to be dynamic and is expected to undergo periodic revisions as project scope and design criteria are further defined and modified.

1.1 Project Understanding

The project understanding is based on the task order description scope of work contained in the "Baseline Change Request, 96-096" submitted by ERC on March 6, 1996, and approved by U.S. Department of Energy, Richland Operations Office (DOE-RL), on March 14, 1996 (IOM, March 14, 1996).

The project design shall be executed in two phases: conceptual design (Phase 1) and final design (Phase 2).

Design rationale and other supporting information developed during design shall be presented in a separate document titled *Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Operable Units*. This document shall be prepared during final design and shall serve as the primary reference document for the project.

The conceptual and final design work shall produce the following project deliverables:

Phase 1: Conceptual Design

The conceptual design effort shall produce the following:

1. <u>100-HR-3 Design Criteria</u>. Presented in Chapters 2 through 4 of this document.

2. <u>100-KR-4 Design Criteria Addendum</u>. Due in June.

3. <u>Conceptual design package</u>. Includes the following:

   a. Process and instrumentation diagram and selected piping drawings

   b. Pump-and-treat system design description

   c. Preliminary results of cultural resource survey(s), hazard classifications, site evaluations, and safety assessments

   d. Preliminary construction cost estimate and schedule.

4. <u>Procurement strategy</u>.

Phase 2: Final Design

The final design effort shall produce the following:

1. <u>Final design package</u>. To contain:
   a. Detailed drawings and specifications for the 100-HR-3 and 100-KR-4 balance of plant (BOP) including a construction cost estimate and scope of work for the procurement package.

   b. Treatment skid specification, construction cost estimate, and scope of work for the procurement package. BHI shall assist in developing the initial treatment system operation and performance criteria for use by CHI in developing the skid specification.

2. <u>Description of Work (DOW)</u>. Well drilling: This document is on an accelerated schedule to allow fieldwork to be completed by October 1996 and has been prepared independently and prior to completion of the final design package. A single DOW has been prepared to include work for the 100-HR-3 wells and 100-KR-4 wells (BHI, 1996a).

3. <u>Remedial Design Report and Remedial Action Work Plan (RDR/RAWP)</u>. This document shall provide an updated conceptual model of chromium distribution based on sampling results obtained between January 1994 and August 1995. It shall show the rationale used in selecting groundwater extraction, injection, and compliance monitoring well locations, describe system startup and operation procedures, and describe methods for evaluating the performance and effectiveness of the interim remedial measures (IRM). The RDR/RAWP shall cover the 100-HR-3 IRM and the 100-KR-4 IRM.

1.2 Project Schedule

The following completion dates are anticipated based on the proposed project schedule (Figure 1-1):

1. April 15, 1996 - Revision A drawings and specifications for 100-HR-3
2. April 30, 1996 - Draft DOW for well drilling
3. May 3, 1996 - Revision A drawings and specifications for 100-KR-4
4. May 20, 1996 - Decisional Draft RDR/RAWP
5. June 17, 1996 - Revision 0 specifications and drawings for 100-HR-3
6. June 28, 1996 - Revision 0 drawings and specifications for 100-KR-4
7. July 8, 1996 - Issue procurement package for treatment skids and BOP for 100-HR-3 and 100-KR-4.

1.3 Roles and Responsibilities

CHI shall act as the "design agent" with responsibility for preparation of documents, drawings, and specifications described above in accordance with CHI and BHI procedures in effect as of February 1, 1996. BHI will serve as the "design authority" responsible for providing technical direction to the design agent, while DOE-RL retains the capacity of "owner" responsible for top-level functional requirements. For each BHI document and design drawing/specification review, CHI shall prepare comment resolution summaries and modify documents, drawings, and specifications as necessary to address BHI technical comments.

During procurement and construction, CHI shall provide technical support as required for the following:

1. Interpreting drawings and specifications

2. Reviewing contractor submittals within specified requirements and evaluating the substitution or replacement of specified equipment

3. Visiting the site periodically for inspection/verification

4. Reviewing startup and functional testing data

5. Providing technical support during startup

6. Programming the remote telemetry unit and programmable logic controllers (PLC).

BHI will review drawings and specifications for procurement and construction requirements and general technical adequacy. BHI will prepare and submit to CHI written comments on documents, drawings, and specifications after each review event. Specific areas of review include safety, operability, cost, and regulatory conformance.

BHI will prepare the final procurement package which is expected to include instructions to bidders, bid forms, conditions for progress payments, document submittal requirements, instructions for construction, health and safety, quality assurance, change orders, specifications for contractor performed functional/startup testing, and final acceptance criteria. Where possible, preparation of the final procurement package will occur concurrently with final the design activities. The design package will be completed by June 28, 1996. Bid packages will be completed by close of business on July 8, 1996.

TPCN	Activity Description	Percent complete	FY95 (A S) / FY96 (O N D J F M A M J J A S) / FY97 (O N)
100-HR-3 (H) IRM DESIGN			
CONCEPTUAL MODELING			
PE2GA	[PE2GA] UPDATE CONCEPTUAL MODEL	56	02OCT95A – 30SEP96
PE2GB	[PE2GB] SUMMARY OF CONCEPTUAL MODEL	90	18DEC95A – 19JUN96
PRE-DESIGN ACTIVITIES			
PE2BB	[PE2BB] NUMERICAL MODELING	100	02OCT95A – 19APR96A
PE2CB	[PE2CB] DETAILED PROJECT PLANNING & ENG.STUDIES	100	02OCT95A – 30JUL96
PE2CC	[PE2CC] SITE EVALUATION REVIEWS AND PERMITS	100	02OCT95A
PE2CD	[PE2CD] PROCUREMENT STRATEGY	100	22JAN96A – 19APR96A
PE2DE	[PE2DE] EXISTING WELL PERFORMANCE TEST	100	02NOV95A – 01FEB96A
	DESIGN STARTUP	100	12MAR96A
CONCEPTUAL DESIGN			
PE2DG	[PE2DG] DESIGN CRITERIA	70	01FEB96A – 28JUN96
PE2DN	[PE2DN] ERC REVIEW	0	17JUN96 – 28JUN96

Project Start 28AUG95
Project Finish 30SEP96
Data Date 22APR96
Plot Date 13MAY96
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Early Bar
Progress Bar
Critical Activity

GWPC

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100-HR-3/KR-4 IRM DESIGN SCHEDULE
TPCN STATUS AS OF 4/21/96
INFORMATION DRAFT

Figure 1-1. Project Schedule (Page 1 of 4)

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TPCN	Activity Description	Percent complete	FY95 (A S) / FY96 (O N D J F M A M J J A S) / FY97 (O N)
PE2DP	[PE2DP] ASSEMBLE CONCEPTUAL DESIGN PACKAGE	100	05MAR96A 29MAR96A
PE2DT	[PE2DT] ERC CONCURRENT REVIEW	90	22APR96 07JUN96
FINAL DESIGN			
PE2EA	[PE2EA] FINAL SYSTEM DESIGN DRAWING	40	12MAR96A 17JUN96
PE2EC	[PE2EC] ERC CONCURRENCE ENG/TECH REVIEW OF DESIG	10	15APR96A 17JUN96
PE2EF	[PE2EF] WELL DOW	80	01MAR96A 22JUL96
PE2EL	[PE2EL] PROJECT IMPLEMENTATION PLANS	5	15APR96A 13JUN96
PE2EM	[PE2EM] PREPARE FINAL DESIGN PACKAGE	0	17JUN96* 28JUN96
REMEDIAL DESIGN/REMEDIAL ACTION WORK PLAN			
PE2EG	[PE2EG] RD/RA DOCUMENT	25	20FEB96A 09AUG96
PROJECT SUPPORT			
PE2FA	[PE2FA] PROJECT SUPPORT - HR-3 IRM DESIGN	56	02OCT95A 30SEP96
100-KR-4 IRM DESIGN			
KR-4 CONCEPTUAL MODEL			
PC111	[PC111] UPDATE CONCEPTUAL MODEL	56	02OCT95A 30SEP96

Figure 1-1. Project Schedule (Page 2 of 4)

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TPCN	Activity Description	Percent complete	FY95 A S / FY96 O N D J F M A M J J A S / FY97 O N
PC112	[PC112] SUMMARY OF CONCEPTUAL MODEL	80	18DEC95A – 10MAY96
RIVER SUBSTRATE SAMPLING			
PC212	[PC212] PORE WATER SAMPLING FIELD TEAM	100	20NOV95A – 19JAN96A
PC213	[PC213] PORE WATER LAB ANALYSIS BY PNL	100	20NOV95A – 19JAN96A
PC214	[PC214] PORE WATER SAMPLING SUBCONTRACT	100	20NOV95A – 19JAN96A
PC216	[PC216] PORE WATER SAMPLING PROJECT MANAGEMENT	100	02OCT95A – 19JAN96A
PC2A6	[PC2A6] GW DISCHARGE MONITORING - SAMPLING	90	20NOV95A – 14MAY96
PC2A7	[PC2A7] GW DISCHARGE MONITORING-ANALYSIS	30	20FEB96A – 30SEP96
PRE-DESIGN PLANNING			
PC211	[PC211] EXISTING WELL PUMP TESTING	100	01MAR96A – 23MAR96A
PC217	[PC217] SITE PREPARATION REVIEWS	75	01MAR96A – 17MAY96
PC218	[PC218] CULTURAL RESOURCES AND ECOLOGICAL REVIEW	90	16FEB96A – 31MAY96
PC219	[PC219] DETAILED PROJECT PLANNING & ENG. STUDIES	90	02OCT95A – 17MAY96
PC2A5	[PC2A5] NUMERICAL MODELING	30	04MAR96A – 10MAY96

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Figure 1-1. Project Schedule (Page 3 of 4)

TPCN	Activity Description	Percent complete	Start	Finish
CONCEPTUAL DESIGN				
PC122	[PC122] DESIGN CRITERIA REVISION	80	25MAR96A	10MAY96
PC124	[PC124] ERC REVIEW & REVISION	0	13MAY96	30MAY96
PC126	[PC126] ASSEMBLE CONCEPTUAL DESIGN PACKAGE	80	22APR96*	13MAY96
PC128	[PC128] ERC CONCURENT REVIEW	0	14MAY96	05JUN96
FINAL DESIGN				
PC132	[PC132] FINAL SYSTEM DESIGN DWG's & SPEC's	20	01APR96A	27JUN96
PC134	[PC134] ERC CONCURRENT ENG/TECH REVIEW OF DESIGN	10	16APR96A	27JUN96
PC136	[PC136] WELL DOW	60	25MAR96A	22JUL96
PC139	[PC139] PREPARE FINAL DESIGN PACKAGE	0	17JUN96*	28JUN96
REMEDIAL DESIGN/REMEDIAL ACTION WORK PLAN				
PC142	[PC142] PREPARE RD/RA WORK PLAN	20	11MAR96A	09AUG96
PROJECT SUPPORT				
PC2D1	[PC2D1] PROJECT SUPPORT - KR-4 IRM DESIGN	56	02OCT95A	30SEP96

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Figure 1-1. Project Schedule (Page 4 of 4)

2.0 PROJECT DESIGN CRITERIA

2.1 Purpose

This chapter presents background information and design standards for use in developing the pump-and-treat designs for 100-HR-3 and 100-KR-4. The project objectives as defined in the ROD and the selected remedy to address the chromium contaminants are discussed.

2.2 Background of Problem

The chromium contamination problem at 100-HR-3 and 100-KR-4 is described as follows in the final version of the ROD:

"During the years of reactor operations, large volumes of reactor coolant water containing chromium and radionuclides were discharged to retention basins for ultimate disposal in the Columbia River through outfall pipelines. Liquid wastes, containing significant quantities of chromium from reactor operations, were also discharged to the soil column at cribs, trenches, and french drains. Contaminant plumes in groundwater resulted from these former waste disposal practices. Groundwater contaminated with chromium is present beneath the 100-D/DR, 100-H, and 100-K Reactor areas and is migrating toward, and discharging into, the Columbia River. The groundwater upwells into the river through the riverbed with minor contributions from riverbank seepage."

"As a result of the discharge of groundwater from the operable units into the river, chromium, a metal that is toxic to aquatic organisms in low concentrations, poses a risk to aquatic organisms in the Columbia River adjacent to the 100-D/DR, 100-H, and 100-K Areas. The most toxic form of chromium, hexavalent chromium, readily dissolves in water and, therefore, moves freely with groundwater. Hexavalent chromium has been detected in groundwater and in the groundwater/river interface where groundwater upwells into the river. Once discharged to the river, it is easily assimilated by aquatic organisms, some of which are adversely affected. Trivalent chromium is less soluble and less toxic, and is not easily transported by groundwater. Most chromium in groundwater at the Hanford Site is hexavalent chromium, because of the original sources and prevailing geochemical conditions."

2.3 Project Objectives

The purpose of this design project is to prepare drawings, specifications, and a design package to be used in the procurement and construction of groundwater pump-and-treat systems for the 100-HR-3 and 100-KR-4 groundwater operable units.

The remedial action objectives (RAO) for this project include the following:

- Protect aquatic receptors in the river bottom substrate from contaminants in groundwater entering the Columbia River
- Protect human health by preventing exposure to contaminants in the groundwater
- Provide information that will lead to selection of the final remedy.

The first and second objectives will be achieved by pumping groundwater from extraction wells located adjacent to the Columbia River. Extracted groundwater will be conveyed to an above-ground treatment system where chromium will be removed and the treated groundwater will then be injected back into the aquifer. BHI will operate the pump-and-treat systems using procedures to be developed in subsequent implementation documents.

The second RAO shall be achieved through control of the site.

The third RAO shall be met by the collection of site-specific cost, water level, and water quality data coupled with the use of the groundwater extraction and treatment systems.

Additional information on the scope and objectives for the 100-HR-3 and 100-KR-4 IRM is described in the *Proposed Plan for Interim Remedial Measure at the 100-HR-3 Operable Unit* and the *Proposed Plan for Interim Remedial Measure at the 100-KR-4 Operable Unit* (DOE-RL, 1995a and 1995b, respectively).

2.4 Selected Remedy

The selected remedy must meet the RAOs and satisfy the applicable or relevant and appropriate requirements (ARARs). The remedy is summarized in the ROD as follows:

"The selected remedy is an interim action that involves removing hexavalent chromium from groundwater that discharges into the Columbia River. To intercept the chromium plumes, groundwater will be pumped from approximately 30 wells located along and inland from the river shoreline. The water will then be treated using an ion exchange (IX) treatment technology to remove chromium. The treated effluent will then be returned to the aquifer using injection wells located upgradient of the existing chromium plumes. The interim action includes monitoring of the groundwater near the river and the effluent from the treatment system to determine system performance in meeting the remedial action objectives for protection of the Columbia River. The interim action also involves institutional controls to protect human health from groundwater contaminants."

2.5 Design Standards

The standards and criteria listed in this section shall be followed for design of the pump-and-treat facilities.

2.5.1 Regulatory Criteria

Regulatory criteria in the final version of the ROD require the following:

"The groundwater treatment systems will reduce the effluent chromium concentrations to the maximum extent practicable. However, groundwater above 50 μg/L chromium will not be discharged."

The ROD requires that concentrations be lowered to less than "22 μg/L hexavalent chromium" at compliance monitoring points and that compliance monitoring "shall be conducted at sufficient locations to evaluate the performance of the remedial action." Other specific criteria from the ROD and their design impacts are described in the design basis.

2.5.2 Process Criteria

Hexavalent chromium is the only constituent requiring treatment and removal under the IRM. References to co-contaminants, which appeared in the focused feasibility study and the proposed plan, suggest that some beneficial removal of co-contaminants will be realized during the IRM (DOE-RL 1995c and 1995a, respectively). If any co-contaminant removal occurs, it will be coincidental and not by design.

2.5.3 Well Design Standards

New wells shall be designed and constructed in accordance with the following:

- Washington Administrative Code (WAC), Chapter 173-160 standards, "Minimum Standards for Construction and Maintenance of Wells"
- *Technical Specifications for Environmental Drilling Services* (BHI, 1994)
- *100-HR-3 and 100-KR-4 Pump-and-Treat Drilling Description of Work* (BHI, 1996a)

2.5.4 Other Design Standards

Applicable sections of the following standards shall be the design criteria for the 100-HR-3 and 100-KR-4 pump-and-treat facilities:

- <u>Federal Standards</u> - DOE 6430.1A
- <u>State of Washington</u> - WAC 173-303
- <u>National Codes</u> - ANSI B31.3, NEC, UBC

The CHI design staff shall look for opportunities to minimize future decontamination and decommissioning efforts associated with the pump-and-treat facilities.

3.0 DESIGN BASIS

This chapter presents the design basis for the pump-and-treat facilities and a brief description of the major components.

3.1 Site Conditions

Site conditions are presented into the following categories:

- Nature and distribution of groundwater contaminants
- Hydrogeologic conditions
- Site access and facilities support

3.1.1 Nature and Distribution of Groundwater Contaminants

Hexavalent chromium (chromium) is the primary contaminant of concern and the only constituent requiring action under the IRM.

The distribution of chromium in groundwater to be used in determining the geographic scope of the IRM is based on water quality analysis results obtained between January 1994 and August 1995 from existing wells. This period was interpreted as being representative for a range of conditions likely to be present over the course of the IRM. No groundwater discharge monitoring or river substrate monitoring results were used in defining the distribution of chromium in groundwater.

After removing outliers, chromium analysis results for this period were averaged at each monitoring well location and plotted on a site map. Chromium concentration trends over the baseline period were also reviewed for each well location. These trends were used to draw chromium concentration contours for the 50, 100, and 150 ppb levels. Figures 3-1, 3-2, and 3-3 represent the distribution for the 100-H Area, 100-D Area, and 100-KR-4 Operable Unit respectively. Geographic areas along the river shoreline, within the defined 50 ppb contour line, were assumed to represent the geographic scope of the IRM.

3.1.2 Hydrogeologic Conditions

Hydrogeologic design information for the pump and treat consists of the following information (and its source):

<u>100-H Area</u>

1. Geologic logs and existing well construction details (DOE-RL, 1994).
2. "Field Summary Report, 100-HR-3 Well Production Testing" (IOM, January 22, 1996).
3. "Hydrogeologic Design Basis for the 100-HR-3 IRM Pump and Treat" (IOM, March 11, 1996).

Figure 3-1. 100-H Area Chromium Distribution and Well Locations

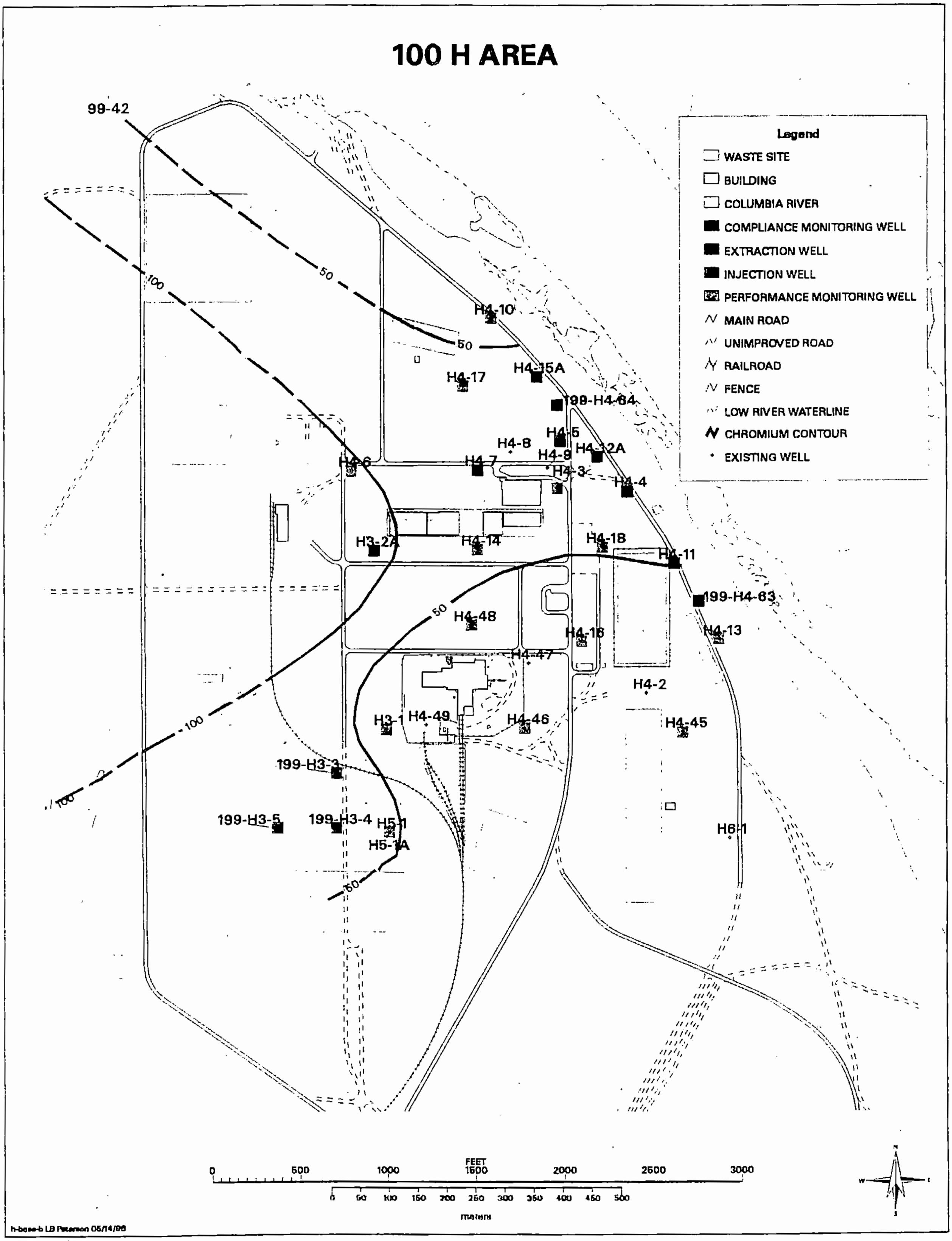


Figure 3-2. 100-D Area Chromium Distribution and Well Locations

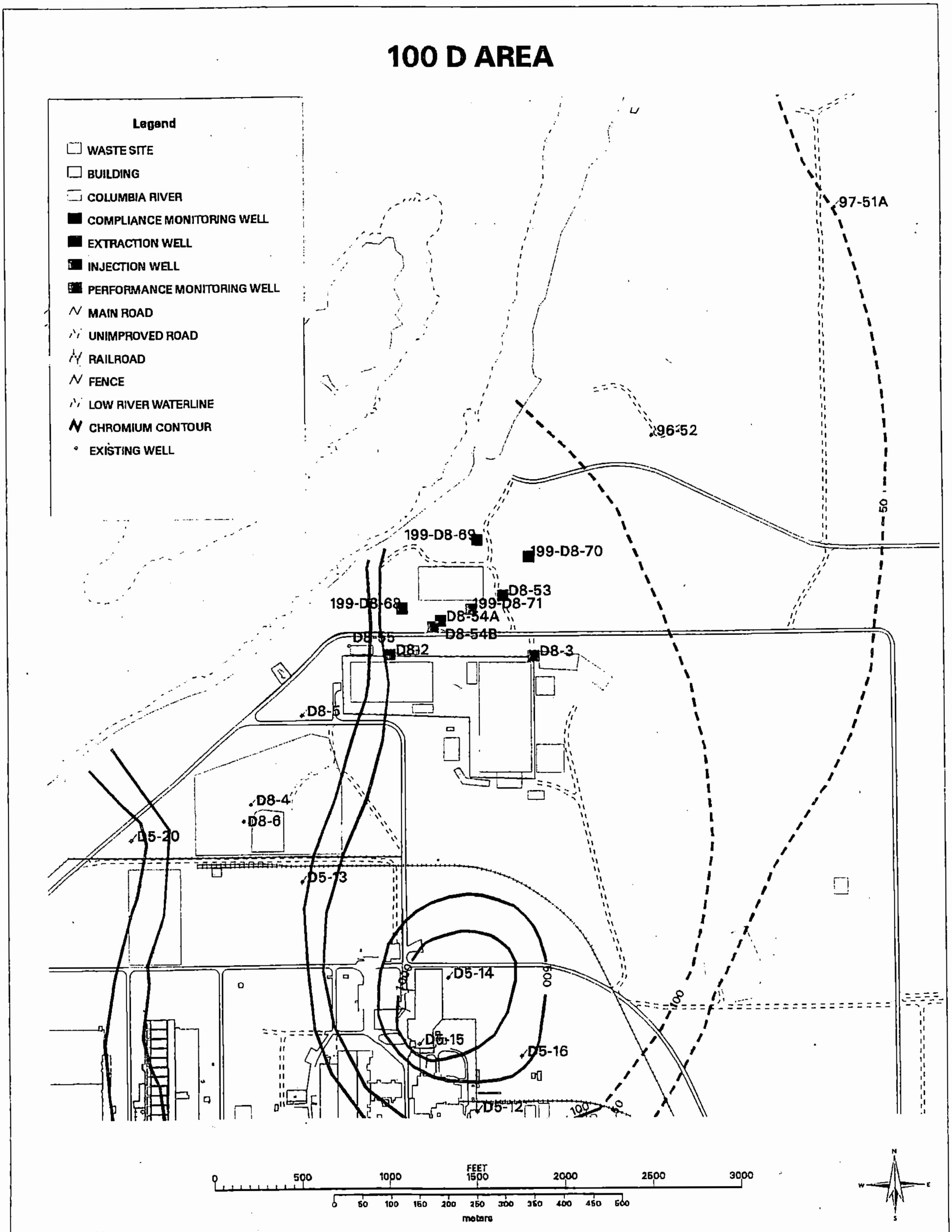
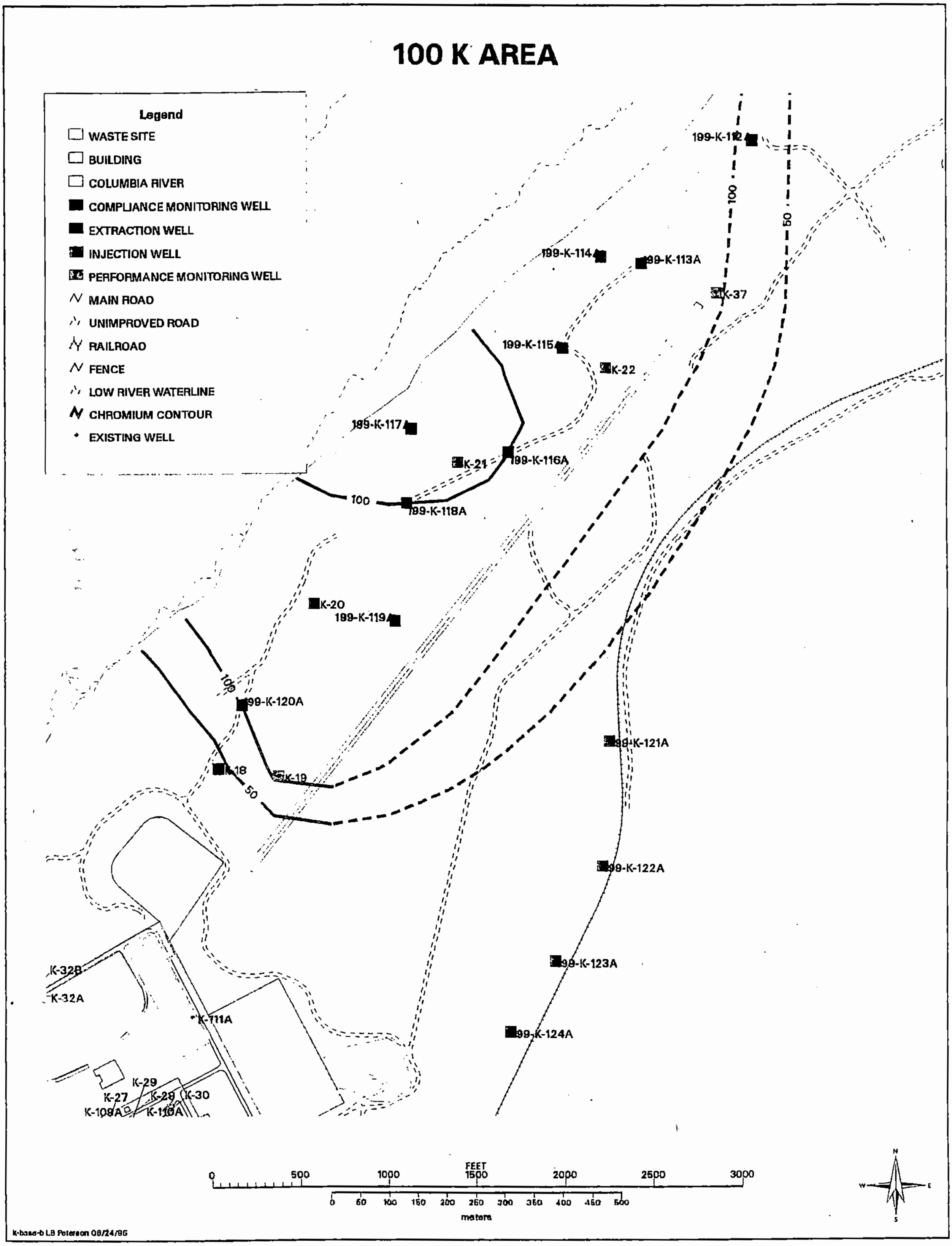


Figure 3-3. 100-KR-4 Operable Unit Chromium Distribution and Well Locations



Additional hydrogeologic information used for the 100-D Area component of the 100-HR-3 IRM design was presented in the "100-HR-3 Well Production Tests and Results" (IOM, October 9, 1995).

Information concerning extraction/injection flow pathways for 100-D Area shall be presented in an interoffice memorandum. Hydrogeologic information for the 100-KR-4 IRM design shall be presented in an interoffice memorandum once the well performance testing and numerical modeling have been completed.

3.1.3 Site Access and Facilities Support

BHI will coordinate and execute formal access agreements necessary for construction and long-term use of facilities within the 100-HR-3 Operable Unit. Access agreements are anticipated for the following:

1. Use of the 1713-H Building to house the groundwater treatment system. CHI has prepared a memorandum of understanding to assist BHI in transferring custodianship of the building from decontamination and decommisioning to field support.

2. Use of existing monitoring wells for extraction and compliance monitoring. CHI has provided a preliminary list of extraction wells to assist in transferring custodianship from the existing owners to field support. An additional request shall be prepared by CHI for the compliance monitoring wells.

3. The well DOW, site reviews, and excavation permits will be obtained for the new injection, extraction, and monitoring wells.

4. Conveyance piping

5. On-site chemical storage

6. Radio-based control system (telemetry) used to monitor and control the 100-D area well and pump facilities from the treatment facility at the 100-H Area (in Building 1713-H). System frequency requirements will be coordinated with Westinghouse Hanford Company radio shop staff. The telemetry system will be designed to accommodate future connection to a 100-Area control system.

7. Resin disposal at the Environmental Restoration Disposal Facility (ERDF).

3.2 Regulatory Requirements

The ROD contains specific requirements which shall be addressed and are, therefore, part of the design basis. These requirements are described in the following sections.

3.2.1 Construction Requirements

Regulatory construction requirements in quotation marks from Section X of the ROD and their interpretation include the following:

1. "Construction is expected to comply with appropriate worker safety requirements."

CHI shall prepare a design package that can be constructed without special health-and-safety requirements beyond what is normally required for Hanford construction activities typical of this type of work. It is anticipated that the pump- and-treat facilities shall be classified as "industrial" activities. The BHI subcontractor shall prepare a construction health-and-safety plan. BHI will be responsible for monitoring and documenting subcontractor compliance with the health-and-safety plan.

2. "In coordination with wildlife and other resource management agencies, activities should avoid or minimize disruption to local wildlife and other natural resources to the extent practicable."

Planned construction activities shall minimize, to the extent practicable, disruption of local wildlife and other natural resources. Where applicable, pipeline routes will be selected along existing roadways or on previously disturbed areas to minimize disruption of resources. Areas disturbed during the project will be revegetated following a restoration and revegetation plan (FY 1997) when access to these areas is no longer needed. Existing structures are being considered for housing treatment and pumping equipment to reduce the amount of new construction. BHI will have final authority on construction activities scheduling and will be responsible for notifying and obtaining any construction schedule variances necessary to comply with wildlife and natural resource requirements.

3. "Design should provide for flexibility following startup to accommodate changes in plume characteristics, or different understandings of actual or perceived responses of the aquifer/plume to the pump-and-treat system."

The design shall incorporate operational flexibility to the extent practicable. Examples of system flexibility include sizing pumps; pipes; and flow control devices to accommodate some variation in pumping rates; and designing compliance monitoring wells so, if necessary, they could be used as extraction wells. Operational flexibility shall be an integral component of overall system design to allow groundwater extraction from areas of concern.

Potential conditions that cannot be managed within the initial design parameters include expansion of the chromium plume beyond the interpreted 50 ppb contour along the river shoreline, injection well fouling, presence of radionuclides, or other co-contaminants at concentrations exceeding historic levels or water quality standards, and hydraulic short-circuiting of near river extraction wells.

4. "For areas that are disturbed during construction and operation, it is expected that the land will be revegetated following construction in those areas that are not needed for operation and maintenance of the treatment system and where the land is also not expected to be re-disturbed within the next few years by other site activities. Following completion of the interim action, it is expected that rectification of the habitat affected by this activity will be conducted and coordinated with activities in the source operable units (100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, 100-KR-1, and 100-KR-2)."

A restoration and revegetation plan will be prepared during Fiscal Year 1997, reviewed with ecological resources staff on the design team, and included as a change order in the BOP contract. BHI will be responsible for implementing and overseeing contractor compliance with the plan. This particular activity was not addressed in the original or revised baseline and will have to be completed under a change request.

A scope of work for restoration and revegetation activities following completion of the IRM is not necessary at this time and should be deferred until additional information on IRM shutdown and decommissioning is developed.

5. "To the extent practicable, facilities are expected to be designed and located in a manner that minimizes interference with and interference by remedial actions for the source waste sites."

CHI shall coordinate with the source operable unit design teams to the extent practicable, to minimize interference or disruption of source operable unit remedial actions. However, given that the scope of work for source operable unit remedial actions is not fully known at this time, there is some potential that conflicts may develop during the work. CHI shall work with BHI construction personnel to develop amicable solutions as necessary.

6. "Sites with cultural resource significance should be avoided during remedial activities if avoidance is possible. Where avoidance is not possible, a data recovery/mitigation plan must be prepared in consultation with the affected resource trustee and carried out for each site impacted by remedial activities."

100-HR-3 and 100-KR-4 design team members shall continue to coordinate and consult with cultural resources staff and provide schedules of activities and maps showing the areas where wells, piping, tanks, roads, and treatment equipment are proposed. 100-KR-4 project details, such as locations and construction requirements, have been identified in the *Treatment Plan for Protection of Cultural Resources for the 100-KR-4 Pump-and-Treat Project*, so that they will be sensitive to cultural resource protection (IOM, June 5, 1996). This document also identifies the necessary data recovery/mitigation activities that must be conducted, such as archeological testing and monitoring.

3.2.2 Compliance with Other ARARs

The selected remedy shall comply with federal and state ARARs included in the ROD. "This interim remedial action addresses chromium in the groundwater and is only part of a final remedial action that shall satisfy other ARAR requirements when completed."

Design assumptions based on ARARs referenced in the ROD include the following:

1. No secondary containment is required for conveyance piping, tank storage, or treatment units because chromium is below toxicity characteristic levels provided by WAC 173-303-090.

2. The groundwater treatment systems will reduce the effluent chromium concentrations to the maximum extent practicable.

3. WAC standards for construction and maintenance of wells apply only to the construction of new, permanent monitoring, and extraction and injection wells.

3.2.3 Operational Requirements

Operational requirements from Section X of the final version of the ROD are in quotation marks followed by their interpretation:

"The pump and treat portion of the interim remedial action will continue until the selection of a final action or it is demonstrated to EPA's and Ecology's satisfaction that termination (or intermittent operation) is appropriate because : (A) sampling indicates that hexavalent chromium is below the compliance value, and site data indicate it will remain below the compliance value; or (B) based on an evaluation of the following criteria:

- The effectiveness of the treatment technology does not justify further operation.

- An alternative treatment technique, such as in-situ chemical reduction or other improved treatment technique is evaluated and provides to be more effective, and/or less costly, and is consistent with the remedial action objectives."

The treatment system and selected equipment, when operated and maintained in accordance with the manufacturer's recommendations, shall have a minimum design operating life of 10 years.

Because of the remoteness of the pump-and-treat sites, system operation will be automated to the extent practicable to minimize the need for daily visits by operations' staff. Extraction, injection, and treatment system operations will be electronically monitored by a remote attendant. A potential future system upgrade may include remote operation.

To meet the ROD, full-scale operation will begin before July 1, 1997, for the 100-HR-3 Pump-and-Treat Facility and before October 1, 1997, for the 100-KR-4 Pump-and-Treat Facility.

Shutdown of the system will be determined based on the results of the compliance monitoring program and final remedy selection. It is expected that the system will continue to operate as long as chromium concentrations in the compliance monitoring wells consistently remain above 22 ppb.

3.2.4 Up-Time Requirements

The ROD states that "The extraction and treatment system shall be designed to run on an essentially continuous basis such that routine procedures such as resin changes and mechanical maintenance can be conducted with minimal impact to system operations."

Various elements of the system shall be designed to be segregated and operated independently to support availability commitments. Continuous system operation cannot be ensured because of loss of electrical power to the site, extended periods of extreme cold weather, equipment failure, and injection well fouling. Any one or more of these conditions may result in partial or complete system shutdown.

A commonly accepted operational goal is 90 percent up-time. "Up-time" means the pump-and-treat system is operating as designed. The 10 percent down-time is attributed to normal, planned operation and maintenance activities that require shutdown of the system. This down-time does not include unplanned shutdown (partial or complete) for any reason.

3.2.5 Resin Disposal

The resin disposal requirements from the ROD follow:

Waste generated during the remedial action, principally exhausted resins, will be disposed of at the ERDF or other on-site facilities as appropriate. There is no plan to regenerate exhausted resin on site. Resins will be stabilized prior to disposal such that toxicity characteristic leaching procedure (TCLP) for chromium is less than 5.0 mg/L, and ERDF waste acceptance criteria are met for any disposal to ERDF.

To meet these requirements, CHI has assumed that spent resin generated from treatment of extracted groundwater will be nonhazardous and will not require routine TCLP characterization, stabilization, or special packaging for disposal. This assumption is based on the results of TCLP chromium and radionuclide testing performed on spent resin generated from the 100-D Area pilot system, which showed the resin to be nonhazardous.

3.2.6 Future Expansion Considerations

The groundwater extraction and treatment systems have been designed such that system throughput can be decreased or increased if necessary. Future expansion considerations include the following:

- Compliance monitoring wells shall be constructed so they can be operated as extraction wells if necessary.

- A modular design concept for the treatment system shall allow additional treatment system capacity to be added or removed.

Any expansion of the system will require preparation of design drawings and specifications, and a subcontractor procurement.

3.3 Well Locations

The IRM shall use a combination of new and existing wells. Extraction and injection well locations for the IRM pump and treats were selected based on numerical modeling results (IOM, March 11, 1996, and May 10, 1996). The modeling effort attempted to use existing wells wherever possible. Proposed locations have been field checked by cultural resources and source operable unit staff and adjustments will be made if necessary.

3.3.1 Extraction Wells

The number and spacing of extraction wells shall be selected to minimize withdrawal of river water and capture the chromium plume to meet the RAOs. The ROD gives the following groundwater extraction well requirements:

"Groundwater will be extracted from wells primarily located along the river in each of the three reactor areas. Extraction wells should be located at a sufficient distance inland from the river to minimize withdrawal of river water. Extraction wells shall be located such that the plume is captured to meet the remedial action objectives."

100-H Area. One new extraction well (3-100H) and four existing wells (H4-7, H4-11, H4-12A and H4-15A) refurbished as groundwater extraction wells would be pumped in the 100-H Area (Figure 3-1) as originally proposed. Future 126-H-2 Source Operable Unit actions are expected to disrupt a large area in the vicinity of Well 3-100H. Consequently, this well will be replaced with an existing Well H3-2A. Well H3-2A is a 15 cm (6 in.) diameter well of similar construction to the other proposed extraction wells and is positioned favorably with respect to the core region of the chromium plume. Well H3-2A should be an effective replacement for well 3-100H.

100-D Area. Based on the numerical modeling results, two existing wells (D8-53 and D8-54A) will be used as the primary extraction wells in 100-D Area (Figure 3-2). No new extraction wells are planned. Compliance wells (D8-68, D8-69, and D8-70) could be connected to the extraction system if additional pumping is necessary during the IRM.

100-KR-4. Six new wells (K-113A, K-115A, K-116A, K-118A, K-119A, and K-120A) are required to capture the chromium plume defined by the existing well network (Figure 3-3) based on the numerical modeling results.

3.3.2 Injection Wells

The final version of the ROD states that "After treatment, water will be reinjected into the upper aquifer, using injection wells located upgradient of the existing chromium plume in the 100-HR-3 and 100-KR-4 Operable Units respectively."

This criterion has been interpreted such that treated groundwater will be re-injected at a site where pre-extraction chromium concentrations are approximately 50 ppb and within an area where reinjected water can flow back toward an active extraction well. Re-injection of treated groundwater from the 100-D Area extraction system at the 100-H Area injection site is assumed to be acceptable.

100-H Area. Three new wells will be constructed in the southwest corner of the 100-H Area (Figure 3-1). The wells are located in a triangular array approximately 100 m (328 ft) apart. Wells H3-3 and H3-5 are the primary injection wells for assessing the effects of injection well mounding. Well H3-4 serves as a backup.

100-D Area. No injection wells are planned for the 100-D Area. Extracted water will be piped to the 100-H Area for treatment and injection (Figure 3-1).

100-K Area. Four injection wells will be constructed in the 100-K Area. The injection area is located southeast of the trench adjacent to and west of the railroad tracks (Figure 3-3). The injection wells will be located in a linear array on spacings of 150 m (429 ft) to 200 m (656 ft).

3.3.3 IRM Monitoring Wells

The interim action ROD requires that concentrations be at or below "22 μg/L hexavalent chromium" at compliance monitoring points and that compliance monitoring "shall be conducted at sufficient locations to evaluate the performance of the remedial action."

The location and number of wells selected for the IRM monitoring program is based on results of the numerical groundwater modeling and existing well spacing intervals.

The IRM monitoring program will consist of two types of wells: compliance monitoring wells and performance monitoring wells. Compliance monitoring wells will be used primarily for collection of water quality samples to demonstrate the effectiveness of the IRM during operation and after system shutdown. Performance monitoring wells are intended to yield water level and water quality data on a much larger scale. This data will be used to track movement of the chromium plume and determine if adjustments to the pumping strategy are necessary.

The compliance monitoring network shall use a combination of the following: (1) new and existing wells located near the riverbank which are screened over similar depth intervals as the extraction wells, will have 1 sample collected per well; (2) where new wells are screened across the entire saturated thickness of the aquifer, samples will be collected at multiple depths within the same well. The performance monitoring network will use existing wells with one sample per well collected.

100-H Area. Compliance monitoring in the 100-H Area will be performed using two new wells (H4-63 and H4-64 in Figure 3-1) and two existing wells (H4-4 and H4-5). As originally proposed, new Well H4-63 was to be placed midway between extraction wells H4-11 and H4-4. However, a buried radioactive waste disposal area extending north from the former 183-H basin makes this an undesirable location for groundwater monitoring. This well was moved to the south side of extraction Well H4-11. New Well H4-64 was staked in the field as shown.

No new performance monitoring wells are planned for the 100-H Area. Existing wells are shown in Figure 3-1.

100-D Area. Compliance monitoring in the 100-D Area will be performed using three new compliance wells (D8-68, D8-69, and D8-70 as shown in Figure 3-2). These locations have been marked in the field as shown.

One new performance monitoring well (D8-71) will be installed on the upgradient side of the extraction system for water level and water quality measurements to confirm the area of hydraulic capture.

100-K Area. Compliance monitoring in the 100-K Area will be performed using three new wells (K-112A, K-114A, and K-117A as shown in Figure 3-3) and two existing wells (K-18 and K-20).

Four existing wells (K-19, K-21, K-22, and K-37) will be used for water level measurements and water quality samples to confirm performance of the IRM system.

3.4 Well Construction Details and Pumping Estimates

Summary information on well construction is included in Table 3-1 and is described below.

3.4.1 Extraction Wells

No new extraction wells are planned for the 100-H or 100-D Areas. Existing 100-H Area extraction wells are generally constructed with 15 cm (6 in.) diameter stainless steel well screens and riser casing. Well screens are 4.5 m (15-ft) long with 0.5mm (0.02 in.) slot screen. Initial pumping rates for 100-H Area are estimated at 37 Lpm (10 gpm) for wells H4-11, H4-12A and H4-15A; 75 Lpm (20 gpm) for Well H4-7; and 150 Lpm (40 gpm) for Well H3-2A.

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Table 3-1. 100-H, -D, and -K Area IRM Wells (Page 1 of 2)

Well No.	Coordinates-mtr North	Coordinates-mtr East	Construction Material Screen	Construction Material Riser	Well Ref. Pt. Elevation-ft	Ground Surface Elev-ft	Screen Interval - FBGS Top	Screen Interval - FBGS Bottom	Bottom Well	Depth - FBGS High Water	Depth - FBGS Average Water	Pumping Rate-gpm	Expected Drawdown-ft	Recommended Pump Depth-ft	Required Pump Lift-ft
100-H Extraction Wells															
H4-7	152891	577804	6" SS #20	6" SS	420.6	418.5	38.0	53.0	53.0	41.7	45.1	20.0	5.5	53.0	60.0
H4-11	152728	578142	6" SS #20	6" SS	416.8	414.9	38.0	53.0	53.0	35.7	46.6	10.0	2.0	50.5	55.0
H4-12A	152913	528009	6" SS #20	6" SS	413.5	411.0	33.0	48.0	48.0	32.1	45.3	10.0	2.0	48.0	55.0
H4-15A	153053	577904	6" SS #20	6" SS	407.2	405.0	27.0	42.0	42.0	25.6	36.0	10.0	2.0	40.0	45.0
H3-2A	152750	577625	6" SS #20	6" SS	418.4	416.6	36.0	51.0	51.0	38.8	45.0	40.0	1.5	48.5	55.0
100-H Injection Wells															
H3-3			6"SS #40	6" CS	NA	NA	33	63	63	NA	43	Backup			
H3-4			6"SS #40	6" CS			36	66	66	NA	46	65			
H3-5			6"SS #40	6" CS			40	70	70	NA	50	65			
100-H Compliance Wells															
H4-4	152854	578061	6" TS #UNK	6" CS	413.7	412.3	37.0	57.0	57.0	32.7	42.5				
H4-5	152940	577945	6" TS #UNK	6" CS	416.2	413.8	28.0	48.0	48.0						
H4-63	NA	NA	6"SS #40	6" SS	NA	NA	33	58	58	37	42				
H4-64	NA	NA	6"SS #40	6" SS	NA	NA	28	53	53	28	32				
100-H Performance Wells															
H3-1	H4-12B	H4-16													
H4-3	H4-12C	H4-17													
H4-6	H4-13	H4-18													
H4-8	H4-14	H4-45													
H4-10	H4-15B	H4-46													
H5-1A	H4-15C	H4-48													
100-D Extraction Wells															
D8-53	152452	573890	4" SS #10	4" SS	436.0	432.5	45.0	65.5	69.4	51.6	56.4	20.0	5.5	53.0	62.0
D8-54A	152728	578142	4"SS#10	4"SS	442.8	439.2	51.5	72.6	78.0	56.0	63.0	10.0	2.0	50.5	65.0
100-D Compliance Wells															
D8-68	NA	NA	6"SS #40	6" SS	NA	NA	66	80	80	56	59				
D8-69	NA	NA	6"SS #40	6" SS	NA	NA	37	62	62	37	41				
D8-70	NA	NA	6"SS #40	6" SS	NA	NA	42	67	67	42	46				
100-D Performance Wells															
D8-71			6"SS #40	6" CS	NA	NA	50	75	75	50	54				
100-K Extraction Wells															
K-113A	NA	NA	6"SS #40	6" CS	NA	NA	20	66	68	20	24	26	10	65	40
K-115A	NA	NA	6"SS #40	6" CS	NA	NA	20	65	68	20	24	25	10	65	40
K-116A	NA	NA	6"SS #40	6" CS	NA	NA	31	76	79	31	36	25	10	76	55
K-118A	NA	NA	6"SS #40	6" CS	NA	NA	31	76	79	31	38	25	10	76	55
K-119A	NA	NA	6"SS #40	6" SS	NA	NA	61	96	99			26	10	96	61
K-120A	NA	NA	6"SS #40	6" CS	NA	NA	16	61	64	16	22	25	10	61	40

Table 3-1. 100-H, -D, and -K Area IRM Wells (Page 2 of 2)

Well No.	Coordinates-mtr North	East	Construction Material Screen	Riser	Well Ref. Pt. Elevation-ft	round Surface Elev-ft	Screen Interval - FBGS Top	Bottom	Bottom Well	Depth - FBGS High Water	Average Water	Pumping Rate-gpm	Expected Drawdown-ft	Recommended Pump Depth-ft	Required Pump Lift-ft
100-K Injection Wells															
K-121A	NA	NA	6"SS #40	6"CS	NA	NA	62	92	96	NA	72	50			
K-122A	NA	NA	6"SS #40	6"CS	NA	NA	65	95	98	NA	75	50			
K-123A	NA	NA	6"SS #40	6"CS	NA	NA	66	96	98	NA	75	60			
K-124A	NA	NA	6"SS #40	6"CS	NA	NA	66	96	99	NA	76	Backup			
100-K Compliance Wells															
K-18	147735	569435	PERF	8"CS											
K-20	147686	569520	PERF	8"CS	NA	NA	10.0	50.0	47.5	31.0	36.0				
K-112A	NA	NA	6"SS #40	6"SS	NA	NA	21	65	69	21	23				
K-114A	NA	NA	6"SS #40	6"SS	NA	NA	19	64	67	19	23				
K-117A	NA	NA	6"SS #40	6"SS	NA	NA	19	64	67	19	24				
100-K Performance Wells															
K-19															
K-21															
K-22															
K-37															

Notes:

1. FBGS = feet below ground surface. TBD = to be determined. Unk = unknown. NA = not available
2. Shaded = new wells

The existing 100-D Area wells are constructed with approximately 6.1 m (20 ft) long, 10 cm (4-in.) diameter stainless steel well screens and casing. Pumping rates for 100-D Area are estimated at 150 Lpm (40 gpm) each for wells D8-53 and D8-54A. Well production tests performed in September 1995 indicate that 40 gpm is a sustainable pumping rate (IOM, October 9, 1995).

New 100-KR-4 extraction wells have been designed in accordance with the following criteria:

1. Groundwater entrance velocities shall be 3.05 mm (0.01 ft) per-second or less.

2. Well screen shall be a stainless steel continuous wire wrap V-slot construction with a 15 cm (6 in.) diameter.

3. Riser casing shall be 15 cm (6 in.) diameter carbon steel.

4. Well screen slot size will be determined from sieve analysis samples.

5. The final well screen and riser casing lengths will be determined from site-specific conditions. Well screens shall straddle the full saturated thickness of the aquifer present at the time of construction allowing for increases to average high level conditions.

Based on geologic logs, approximately 14 m (45 ft) of well screen and 11 m (35 ft) to 17 (55 ft) of riser casing will be required.

3.4.2 Injection Wells

Injection wells shall be used to inject treated groundwater to the aquifer. The success of the 100-HR-3 and 100-KR-4 IRMs depends on the long-term performance of these wells to continually accept water without incurring biological or chemical fouling or entrapped air in the sandpack around the well screen. Conservative well design criteria have been employed due to the limited information on projected performance of injection in the 100 Area. Design criteria for the injection wells include the following:

1. Exit velocities for injected water shall be 15 mm (0.05 ft) per-second or less.

2. Well screen shall be minimum 15 cm (6 in.) diameter stainless steel.

3. Riser casing shall be minimum 15 cm (6 in.) diameter carbon steel.

4. 9.1 m (30 ft) long well screens shall be used with 6.1 m (20 ft) extending below the water table and 3 m (10 ft) above.

5. Actual slot size and filter pack gradation shall be determined from field sieve analyses.

6. Pressure transducers will be placed in each well to monitor water level trends.

In the 100-H Area, two wells operating at 511 Lpm (135 gpm) each are required. A third well shall be used as a backup in the event maintenance is required. This well will also be used for measuring the extent of water level mounding around the injection wells. In 100-KR-4, three injection wells operating at 189 Lpm (50 gpm) each are necessary. A fourth injection well will be installed as a backup and for monitoring injection system performance.

3.4.3 Compliance Monitoring Wells

Design criteria for the 100-HR-3 and 100-KR-4 compliance monitoring wells include the following:

1. Wells shall be equipped with dedicated pumps to facilitate sample collection and eliminate the need for equipment blank samples.

2. Wells shall be constructed with stainless steel well screens and stainless steel riser casing.

3. Actual slot size and filter pack gradation shall be determined from field sieve analyses.

4. Well screens shall be long enough to encompass the full range of seasonal water level variations.

5. Water level and specific conductance in sensors shall be placed in each well for automated monitoring to assist with confirming representative conditions prior to compliance sampling events.

100-H Area. In the 100-H Area the saturated aquifer thickness is generally 3.05 m (10 ft) or less eliminating the need for sampling at multiple depths. The existing and new wells are/shall be constructed so each well screen straddles the saturated interval for the range of water level conditions likely to occur.

100-D Area. In the 100-D Area compliance wells are expected to have 7.62 m (25 ft) screens to allow for sample collection at multiple depths within the aquifer. No special well design or construction considerations are anticipated at this time to provide for this requirement.

100-K Area. In the 100-K Area compliance monitoring wells are expected to have 13.72 m (45 ft) well screens to enable samples to be collected at multiple depths within the aquifer. No special well design or construction considerations are anticipated to provide for this requirement.

3.4.4 Performance Monitoring Wells

The performance monitoring wells in 100-HR-3 and 100-KR-4 shall include the following:

1. Each well shall be equipped with a water level transducer for automated water level monitoring.

2. Pumps from existing wells which are to be converted for extraction, may be placed in wells not equipped with pumps.

Purge water collection and disposal shall be required for the duration of the IRM program for each monitoring well location.

100-H Area. The existing monitoring network is adequate to meet performance monitoring requirements. No new performance monitoring wells are required for the 100-H Area.

100-D Area. One new performance monitoring well is proposed for the 100-D Area, and several other existing wells are being evaluated for potential use. The new performance monitoring well (D8-71) shall be the same construction as the new compliance wells.

100-K Area. No new performance monitoring wells are proposed. Existing wells will be evaluated for use as performance monitoring wells.

3.5 Pumping Discussion and Chromium Concentration

Numerical modeling is a planning tool for predicting aquifer response. The actual aquifer response to extraction well pumping shall be based on groundwater flow maps prepared from assessment monitoring water level measurements. Adjustments to the groundwater extraction system are anticipated and may include pumping rate changes, addition or removal of extraction wells, or cyclic pumping of near river extraction wells to control inflow from the river and reduce unnecessary treatment system hydraulic loading.

Each extraction well shall be equipped with an electric submersible pump that meets the required capacity, and a sample port, to be located inside the transfer pump station, shall be provided for each well. Each extraction well shall be equipped with pressure transducers for water level monitoring.

The following table presents a flow-weighted average estimate of the initial concentration from each area. Representative chromium values were used based on sample data from existing wells or extrapolated values from plume maps for groundwater from extraction wells proposed for the H, D, and K Areas. This average assumes all extraction wells are in service. The Table 3-2 includes an estimate of the maximum concentration from the set of extraction wells for each area.

3.6 Groundwater Conveyance Systems

Extraction System. The conveyance system for the extracted groundwater consists of pipelines installed across the ground surface, and tanks and pump stations.

Conveyance piping from the extraction wells to the treatment system influent tank shall utilize above-ground fusion welded high-density polyethylene pipe. The pipeline design shall follow industry standard and pipe vendor provided criteria. The piping will be routed along existing roadways and disturbed areas as practical to minimize ecological impacts. A combination of engineering features and administrative controls will be used to protect the piping from vehicular damage.

Table 3-2. Initial Cr VI Concentration in Extracted Groundwater

Area	Number of Extraction Wells	Flow-Weighted Average Concentration (μg/L)	Maximum Concentration (From Single Well, μg/L)
100-H	5	90	120
100-D	2	380	480
100-H and -D Combined	7	225	250
100-K	6	120	150

Conveyance pipelines from each extraction well in the H, D, and K Areas will carry groundwater to four extraction transfer tanks. These pipelines shall be designed to allow them to drain back into the wells when not in use for freeze protection. The pipeline between 100-D and 100-H shall be equipped with a manually controlled valve for drainage.

Each of the four extraction transfer tanks shall have level controls to provide tank level alarms and transfer pump controls. The tanks shall be located outside the transfer pump buildings and shall be heat-traced and insulated. The tanks provide a constant discharge head for better control of extraction well discharge and allow for more efficient transfer pumping. Where applicable, tanks shall be provided with additional outlets for future well connection flexibility.

Two transfer pumps shall be provided at each extraction transfer tank at the 100-H and 100-D Areas. One transfer pump shall be provided at the extraction transfer tank for the 100-K Area. The two pumps provide operational flexibility and redundancy. Adjustable frequency drives on the transfer pumps will allow their discharge rates to maintain a selected water level in each extraction transfer tank. The pumps will deliver water to the influent storage tanks at the 100-H and 100-K treatment facilities. Water from the extraction transfer tank in 100-D Area will be pumped to the 100-H Area for treatment. The influent storage tanks shall have a level element to provide control of the transfer pumps and the IX feed pumps.

Pre-engineered metal buildings shall be used for transfer pump enclosures. The buildings will house electrical, telemetry, and transfer pump equipment. The pump enclosure building for the D-Area transfer pump station will be relocated from the N Area (building 109NB). The other two transfer pump stations will be new buildings.

The influent storage tanks at the 100-H and 100-K treatment facilities shall be located inside the treatment building. These tanks, one at each facility, shall provide limited extraction and treatment flexibility needed for routine operation and maintenance activities. These storage tanks and the injection tanks also provide predictable hydraulics which allows the more efficient operation of the influent feed pumps.

Injection System. The injection systems in the 100-H and 100-K both include an injection storage tank, two injection pumps, and conveyance pipelines to transport treated groundwater to the injection wells. Like the extraction conveyance pipelines, injection pipelines shall be high density polyethylene installed directly on the ground. These pipelines shall also be designed to drain when not in use for freeze protection. Each injection well shall be served by a separate control valve and injection pipeline. The injection storage tank volume provides limited operational flexibility. The two injection pumps at each treatment facility are sized equal to the influent feed pumps. The injection storage tanks shall be located inside the treatment buildings.

3.7 Treatment System

Ion exchange shall be used to remove chromium from extracted groundwater. The ROD states that this system "will reduce the effluent chromium concentrations to the maximum extent practicable. Groundwater above 50 μg/L chromium will not be discharged."

CHI began a resin testing program in March 1996 to (1) screen several recommended resins for chromium removal efficiency, (2) determine feasibility of pH adjustment for extending resin life, and (3) develop preliminary data for estimating resin lifetime. CHI presented the test results to BHI in an interoffice memorandum (IOM, May 10, 1996). BHI is responsible for selecting a specific resin and providing technical information for sizing the IX columns. The resin selected for initial operation is SIR-700, manufactured by ResinTech Company.

Modular IX units shall be specified. Each of the modular units at the H and K treatment facilities shall consist of four IX vessels in series. Valving will be provided to allow operations staff to change the flow order through the columns. As the resin in one column becomes exhausted, another column can be placed in the lead position. The exhausted column can be taken out of service, the resin removed as a slurry for dewatering outside of the column, and new resin delivered into the column. Exhausted resin will be dewatered in a drain box and prepared for final disposal.

100-H and 100-D Treatment Facility. Modular (skid mounted) IX units shall be housed in the 1713-H Building where 100-D and 100-H Area groundwater will be combined in the influent storage tank and passed through the IX columns for chromium removal. The sum of the treatment capacity for the modular units will be 1,514 Lpm (400 gpm).

100-K Treatment Facility. Skid mounted IX treatment units will be housed in a new pre-engineered metal building. Groundwater from the K Area extraction wells will be combined in an extraction transfer tank. The total treatment capacity at 100-K shall be 757 Lpm (200 gpm).

Feed Pumps. At both treatment facilities, feed pumps will move the extracted water from the influent storage tank through the IX system and into the injection storage tank. Each pump shall be sized for one-half the rated flow capacity of the IX units. This same size basis shall be used for the injection pumps.

Control System. The control system for the wells, transfer pumps, and treatment system shall be PLC based. Using input from field devices and operator selected values, the PLCs will control extraction, treatment, and injection flow rates. The PLCs will monitor alarm conditions. Remote PLCs will maintain contact with the treatment facility PLCs using radio transceivers. Use of transceivers reduces the need for installation of new telephone lines to these remote sites. The control system shall be designed to allow remote access for monitoring operational status and to ultimately allow consolidating the control of pump-and-treat systems at a remote, central location.

3.8 Project Interfaces

Site services required for operation of the pump-and-treat system include the following:

1. Electrical power
2. Communications
3. Operations and maintenance
4. Site access and parking
5. Disposal for contaminated and non-contaminated waste material.

3.8.1 Electrical Power

Electrical power is required for operation of the well and transfer pumps, system alarm, operations' monitoring, shutdown, telemetry, lighting, heating, and ventilation of the 1713-H Building and transfer pump station. Heating and ventilating of these facilities is based on the buildings being "unoccupied spaces."

3.8.2 Communications

It is expected that operations and maintenance personnel will carry two-way communications devices with them when visiting the site. On-site telephone service will be provided via cellular phones. Telemetry will be used for system monitoring and transfer pump control.

3.8.3 Operations and Maintenance

BHI Field Support will be responsible for site operations and maintenance activities including routine sampling and measurements required for the system performance monitoring program.

CHI shall maintain responsibility for sampling and measurements dealing with aquifer response and related RAOs.

3.8.4 Site Access and Parking

Site access, parking, and work areas shall be required for contractor personnel during construction and by BHI Field Support for the remainder of the operation and compliance monitoring period. Where possible, existing roads shall be used. Where new roads are constructed, crushed rock surfacing shall be used and their layout selected for minimum disturbance of the site.

3.8.5 Waste Pickup and Disposal

Pickup and disposal of contaminated and non-contaminated materials shall be required during construction and system operation. The construction subcontractor shall be responsible for disposal during the construction phase of the work. Operations staff will develop a waste minimization plan and waste control plan for operation of the pump-and-treat facilities.

3.8.6 IRM Performance Monitoring

Trained personnel and laboratory analysis shall be required for groundwater sample collection and evaluation of system operations data.

3.9 General Requirements

The following plans shall be prepared for use during construction and operation of the pump-and-treat system:

1. Operations and Maintenance Plan (includes a readiness review checklist)
2. Performance Monitoring Plan
3. Operations and Monitoring Health-and-Safety Plan
4. Waste Management Plan.

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